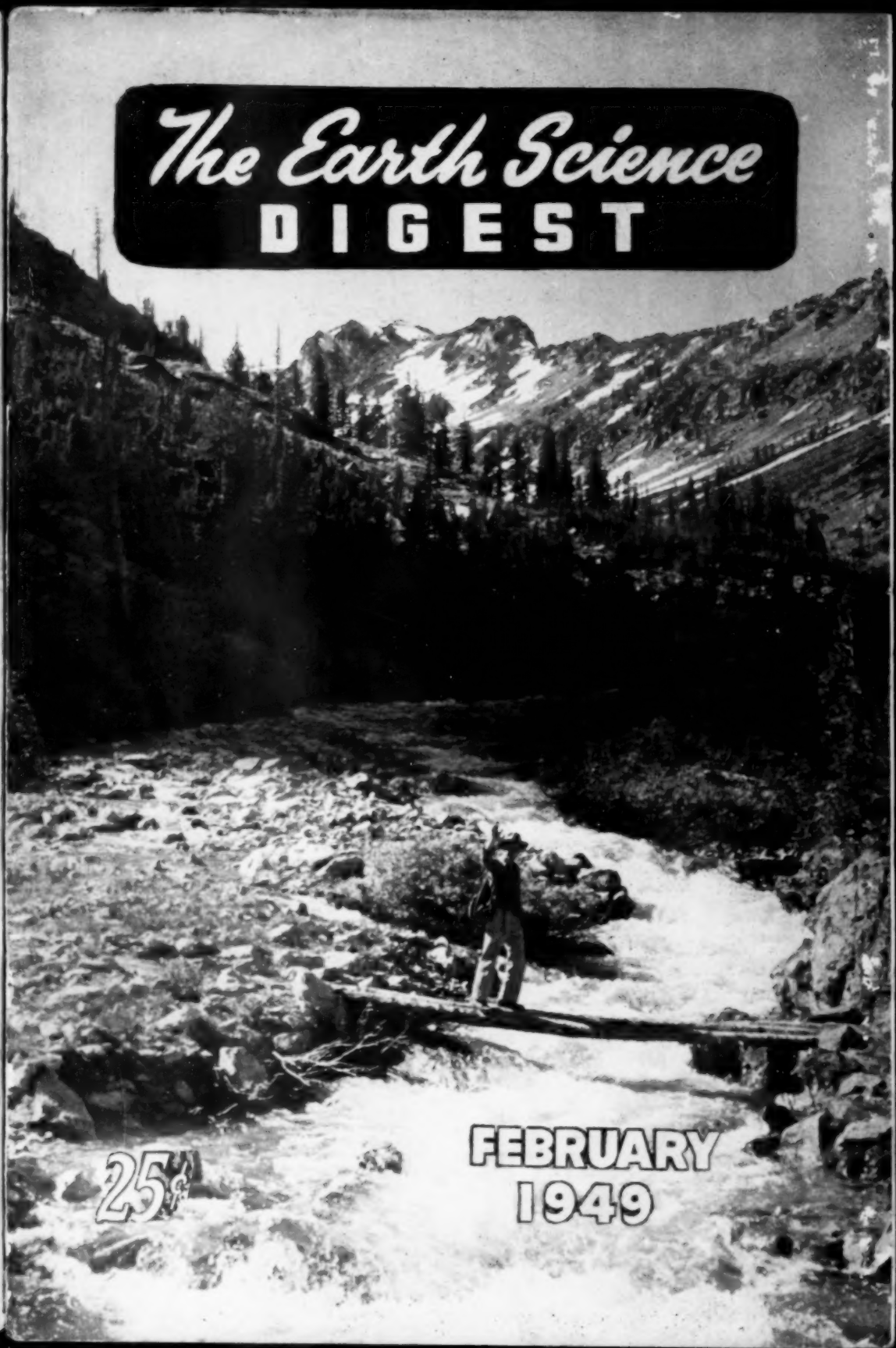
The Earth Science DIGEST



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FEBRUARY
1949

ATOMS, PLANETS and STARS

(AN ASTRONOMICAL WALL CHART)

2nd Edition Revised and Further Developed

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JAMES OLIVER HOGG, Jr.

Rm. 1840E — 160 N. LaSalle St. Chicago 1, Illinois

The Earth Science Digest

Revere, Massachusetts

A magazine devoted to the geological sciences.

THE EARTH SCIENCE DIGEST is open to articles of geologic interest. Manuscripts, photographs and sketches will be returned if accompanied by ample first-class postage.

Subscriptions: U. S. and possessions, Canada, Philippine Is., Latin America, and Spain: 1 year, $2.00; 2 years, $3.75; 3 years, $5.00. Other countries: 1 year, $2.50. Single copies, 25 cents.

Special group subscription rates allowed to educational institutions and societies.

Published monthly by the Digest Publishers Company, 77 Victoria Street, Revere, Mass. Entered as second class matter April 12, 1948 at the post office at Boston, Massachusetts, under the Act of March 3, 1879.

S. Albert Eisenberg, Publisher
Gertrude Roberts, Business Manager

Vol. III FEBRUARY - 1949 No. 7

Contents

COVER PHOTO

Cascade Creek, snow-fed and crystal clear, plunges precipitously over its granite bed in the Grand Teton National Park, and after forming numerous waterfalls, empties into Jenny Lake. One of the most alluring trails in the park follows along this stream.

Photo by H. P. Zuidema.

THE EARTH SCIENCE INSTITUTE

We are pleased to inform our readers that there is now in the process of being formed an organization devoted to the popularization and advancement of the earth sciences. We hope to present further details in the next issue of **The Earth Science Digest.** It is indeed gratifying to note the increased interest in geologic education in the past few years, and it is even more encouraging to know of the enthusiastic interest paid to this much-needed work by the professional geologists and mineralogists, many of whom have been increasingly active in amateur earth science organizations. Perhaps we are fast approaching that time when geology will gain its rightful place among the sciences and command the respect and appreciation, as well as the cooperation, due it.

STATE MINERAL SOCIETY OF TEXAS — SAN ANTONIO APRIL 23, 24

The State Mineral Society of Texas will hold their Annual Mineralogical Show April 23rd and 24th in San Antonio, Texas, with the Plaza Hotel as headquarters. There will be a registration charge of $2. per table for exhibits, and those persons intending to have displays are requested to make reservations well in advance so that all necessary arrangements can be made.

The annual Battle of Flowers, a colorful San Antonio pageant and parade, will be held the week of April 18th through the 24th, and this spectacular pageant is certainly worth travelling many miles to see.

For further information, write to Mr. J. J. Brown, President of the Society, 302 Walton Building, Austin, Texas.

SEDIMENTARY ROCKS AND DANA'S MINERALS

As this issue goes to press, we are pleasantly surprised by the arrival of two new books: **Sedimentary Rocks** by Dr. F. J. Pettijohn, and **Minerals and How to Study Them** by Dr. Cornelius S. Hurlbut, Jr. **Sedimentary Rocks** may well prove to be a "classic" among texts. The photomicrography is superb — 104 outstanding photomicrographs appear in the book. **Minerals and How to Study Them,** the last edition of which appeared in 1895, was considered quite out of date by most amateurs, until Dr. Hurlbut did his excellent rewriting of the book. Reviews of both works will appear in the March **Earth Science Digest.**

NEW CLUB FORMED IN MICHIGAN

The Northwestern Michigan Mineral Club was organized on December 14, 1948. Mineral collecting and lapidary work will be emphasized. Membership is open to anyone in that part of the country. "Visitors are always welcome at all meetings." Address all correspondence to the Secretary, Mr. James C. Moulton, 341 West Front Street, Traverse City, Michigan.

ATOMS, PLANETS AND STARS

The second revised edition of this unusual wall chart was recently published. We know of no other publication which presents the earth scientist with so vast an amount of information on the earth, its constituents, and the solar system, in so small a space. This chart is published by Mr. James Oliver Hogg, Jr., Rm. 1840E, 160 N. LaSalle St., Chicago 1, Ill.

The Moonscar Upon The Earth

HARALD KUEHN
Iserlohn, Westphalia, Germany
Translation by Wolfgang V. Swarzenski, Boston University

Part One of a Two-Part Article

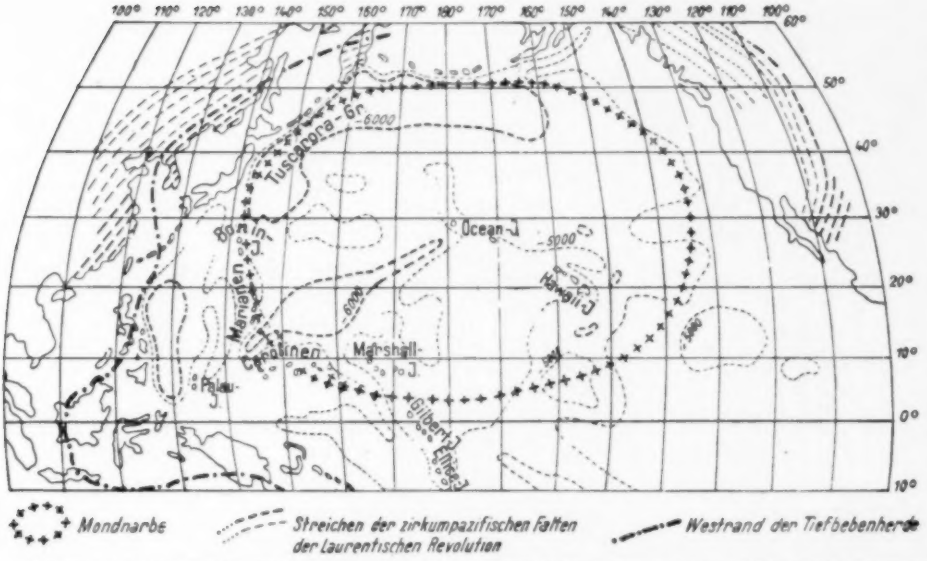


Figure 1. The North Pacific Depression, the deepest indentation of the earth's crust, showing the "moonscar" (mondnarbe), the strikes of the circum-Pacific faults of the Laurentian Revolution (streichen, etc.), and the world's deepest foci for earthquakes (westrand, etc.).

The miraculous telescopes and precision instruments of our observatories have greatly diminished the seemingly infinite distances to the stars. Particularly the moon, our satellite, has come to an almost tangible nearness, permitting observation by our scientists.

As we know, the moon has no atmosphere. The action of water and wind is unknown there. Consequently, there is no transposition of rocks on the moon; there are no sediments. Probably there is surface weathering because of the great differences in temperature between "day" and "night." But the debris will remain stationary, without any further breaking-up processes in depth. Thus the moon's surface corresponds roughly to the earth's magmatic rocks. The color of a plane can be determined by the relationship between incident and reflected light. This ratio, called albedo, has been calculated for the moon's surface. The moon's coloring corresponds largely to that of quartz porphyry. The lunar "seas," comprising the smaller part, are still darker; their color is that of dark, damp soil. The polarization angle of light reflected from the surface of these seas has been measured and compared to that of light reflected from the polished surfaces of the earth's volcanic rocks. The figures thus obtained indicate that the rocks of the moon seas correspond to our vitrophyre.

The results, obtained by the most

different methods, agree in that the moon's surface consists of a dark, glassy, hardened volcanic rock, more closely related to our glassy liparite and trachyte than to our glassy basalt.

If we assume the surface relief of the moon, which closely resembles in appearance our shield volcanoes, to be of magmatic origin, further conclusions are possible. Without forgetting that these forms might possibly be of non-volcanic origin, let us first examine the possibility of volcanism. According to our knowledge, only super-heated basaltic magma, in its highly liquid state, has reached the surface of the earth. Therefore, all our shield volcanoes have been built by basaltic rocks. The moon magma is, as we have ascertained, of acid nature. Contrary to those of the earth, the shield volcanoes of the moon must have been formed by acid magma. Because of higher temperatures, the moon magma must have reached a state of fluidity never equaled by the earth's molten material, under lower temperature conditions. The super-heating of the moon's acid magma, as compared to the earth's, may be explained by linking the moon magma to a single, centrally located magma reservoir. Terrestrial volcanism, however, is probably due to many limited magma chambers whose concentric depth zones correspond to the earth's shells.

Naturally, the similar composition of the earth and moon is also expressed by their respective densities. The average density, 5.51 for the earth and 3.35 for the moon, does not prove much. The picture changes by substituting the density value for the outer-shell of silicates, which is 3.83; it is very close to that of the moon.

Having learned about these various relationships, we should not be astonished at the assumption that an early stage existed in which one uniform, coherent mass comprised the earth and the moon, the double planet rotating around a common center of gravity, the sun. Another hypothesis claims that at one time the moon, on its course through the universe, came so close to the earth that it could not free itself from the earth's gravitational force; hence it remained her satellite. However, it is at least just as plausible that at one time the moon became separated from a common earth-moon mass. Of course, because of its chemical composition and density, one has to assume that the moon originated solely in the earth's outer-shell of silicates.

It has been attempted to determine the time at which the moon became a factor in the earth's development. It is generally known that the moon, by gravitational forces, causes the tides of our oceans. The moon is not only responsible for the tides of our water bodies, but also for the "tides" occurring on the earths' solid crust. Of course, these latter tides are not as conspicuous as those of the oceans. At the latitude of Frankfurt on the Main, half-daily tidal fluctuations have been measured on solid ground, amounting to approximately 1.6 feet. One can readily imagine the moon's retarding influence upon the earth's rotation, causing a decrease of its velocity. The rotation period has thus been increased by one hour in 300 million years. It is possible that in the course of the earth's development its rotation has been increased from a possible minimum of 2 hr., 25 min. to today's 23 hr., 56 min.

Besides the moon, the sun also exercises her influence upon the earth, causing tides in a similar

way. Tides caused by the sun exist to-day and have always existed, before and concurrently with lunar tides. Solar tides, however, are of a much smaller amplitude, being only 1/3 to 1/2 of that of lunar tides.

Assuming that the moon was split off the earth, this calculation can be carried further. The moon, in its rotation around the earth, covers a distance of 0.648 miles per sec. This velocity was transmitted to the moon by the earth; consequently, it must correspond to the velocity of a point along the earth's equator (today: 0.289 miles per sec.) at the splitting-off time. It can be calculated that at that time the rotation period of the earth was approximately 9 hr., 45 min. If, at the beginning, the rotation period had been of the shortest possible duration, one must assume that during the time prior to the splitting-off, "solar" tides alone caused a rotational delay of 9¾ hours. With the beginning of lunar tides, the rotation velocity of the earth had to decrease more rapidly. Using the present-day value of retardation, one finds that the increased loss of velocity occurred approximately 3⅓ billion years years ago. The moon probably has accompanied the earth since that time.

The value thus obtained has to be regarded as a minimum, since during the earth's history this retardation was interrupted by periods of acceleration. At present, i.e. since the middle Miocene, the earth's velocity is continuously decreasing. The alternating periods of retardation and acceleration might possibly be manifest in the structural and tectonic development of the earth's crust, as in the various tectogenic phases. If the moon was split off at all, it must have occurred not later than during Archeozoic, more likely during early Archeozoic times.

There must be evidence in the history of the earth of the time at which the moon gained its influence upon the earth, causing more intense tides. It is quite understandable that such proof cannot be furnished, since we know neither fossils nor rocks of the period in question which might be suitable for an inquiry in this direction. Still, an attempt has been made to find examples of fauna or flora characteristically associated with the tides, and these were correlated to forms in older formations. Up to the present time, no practical results have been obtained. Proof can only be expected from large-scale investigations.

Preliminary reports, however, indicate that boring porifera, boring molluscs, cap-shelled gastropods, and other forms which are characteristically associated with coasts of high tides, have occurred in early Paleozoic times. Some authors have related the formation of marine calcareous and ferruginous oolites to the tides. Besides large-scale evaporation, tides of a magnitude produced only by the moon are said to be necessary for the formation of these oolites. Up to date, investigations have revealed the presence of oolites in all post-Archeozoic formations. They were already present in Algonkian finds from Transvaal and South West Africa. If the formation of oolites is connected with the presence of strong tides, it must be assumed that in the Algonkian there were already lunar tides in our oceans. Therefore, the conclusion seems justified that the moon has rotated around the earth since at least the end of Archeozoic times rather than since Paleozoic time, as stated in another hypothesis.

A further attempt was made to explain the origin of the moon by the conglomeration of meteorites.

One can hardly agree to that. 92% of all meteorites known on earth consist of nickel iron. However, we know that the moon is composed mainly of silicates. It would have been a very improbable coincidence indeed, if only stony meteorites had combined to form the moon!

How can we visualize this often mentioned process of the moon splitting off the earth? Pickering thought that the tidal movements of the earth's crust would have been sufficient, without the necessity of a special impulse. He believed that the common earth-moon mass, while hardening, had passed through all forms of equilibrium to which a rotating fluid is subjected, in proper sequence: the rotation ellipsoid, the tri-axial ellipsoid, and finally, a pear-shaped body. The latter body, being unstable, had crumbled the mass of its narrow part to become completely separated, as the moon.

This, however, is mechanically impossible, since the rotational momentum of the earth-moon mass was in any case too small to create the pear-shaped body at all. The latter could have been formed only under conditions of a density 1300 times larger than today's. Had the moon become separated from an ellipsoid or pear-shaped body without external impulse, its size and weight would be different.

Still, the moon's density and the peculiar ratio of its olivine core (Fig. 2) make its splitting off the earth probable. This splitting-off process, however, cannot be explained without the action of external forces. Quiring assumes that this impulse was given by the impact of a huge meteorite which shattered the then relatively thin crust, dislocating large masses of it. Consequently, a great release of pressure upon the magma under the crust ensued. Gigantic,

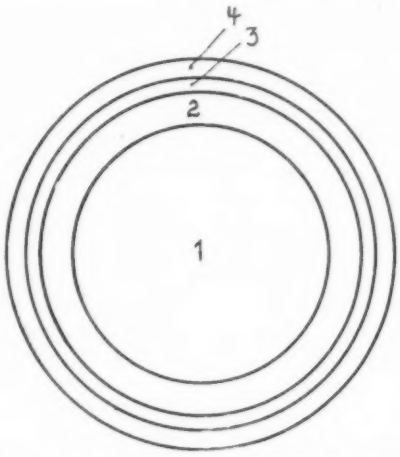


Figure 2. A section through the moon, showing the inferred principal zones and their composition. 1. Hortonolith (olivine) core. 2. Dunite shell. 3. Pyroxenite shell. 4. Sial-Sima crust.

red-hot magma protuberances were ejected into space, with a velocity of 8.1 to 10.5 miles per second. This velocity would be sufficient for these masses, under centrifugal acceleration, to become satellites of the earth. The so-called separation velocity of the earth is 7 miles per second, which means that such high initial velocities are necessary for a body to leave the earth's surface and free itself of her gravitational forces. The sun's separation velocity is fifty times as fast.

The large meteorite which was responsible for the Arizona crater might serve as an alluvial, small-scale example for the meteorite which produced the moon. According to Quiring the impact occurred at a location on the earth's crust which even today shows the greatest depression, namely in the area of the Pacific Ocean. Pickering, at an earlier time, also believed that the moon was split off from the same area. At the impact, a mass of the solid crust must have been torn off, whose area equaled that of Africa (11,600,000 square miles).

(End of Part I)

Staurolite

And Its Occurrence In Georgia

A. S. FURCRON
Georgia Department of Mines, Mining and Geology

Staurolite is a well-known mineral in the rocks of the eastern states; that is, certain formations which occur in the great area of crystalline rocks between New England and Alabama. The curious tendency of staurolite crystals to cross at various angles has created much interest in them, not only by mineralogists who are interested in the study of the development of these crystals but by collectors and others interested in minerals.

The names "fairy stones" or "fairy crosses" have been applied to staurolites for many years, and date back to an invented story distributed in printed form by salesmen. According to this legend, tears shed by the fairies at the time of the crucifixion turned into crosses. The account which I have read does not explain how tears could correspond to the composition of so complex a silicate or work their way so deeply into fresh solid rock. No explanation was offered to account for the presence of so many fairies over the Wissahickon formation of Virginia and the Great Smoky formation of Georgia at that time. The story, however, created thousands of sales, and Dr. T. L. Watson, State Geologist of Virginia, was once reproved for publicly discrediting it.

Staurolite is not especially a gem mineral but is used more as a charm and frequently as a pendant. Dr. Richard M. Pearl, in his book **Popular Gemology,** states that it seems to be the only gem besides pearl that is worn in its original state, with no treatment necessary except drilling so that it may be hung on a chain or suspended from a swivel.

Chemical and physical properties

Staurolite is a very complex mineral chemically, and we will not dwell upon its composition in this article. It is usually written $HFeAl_5Si_2O_{13}$, but generally is more complex because it may contain other elements. The average staurolite crystal, excluding inclusions, will contain about 30 per cent silica (SiO_2), 50 per cent alumina (Al_2O_3), 13 per cent ferrous iron (FeO), a small amount of magnesia (MgO); also a small amount of water of crystallization (H_2O). Genth states that a staurolite from near Canton, Georgia, contained 7.13 per cent zinc oxide (ZnO). Staurolite is infusible except for that variety which contains an appreciable amount of manganese, in which case it fuses to a black magnetic glass.

Its hardness is 7 to 7.5; specific gravity 3.4 to 3.8. Its color is generally reddish brown to brownish black, but where the crystals are altered on the outside, the true hardness and color cannot be determined. A considerable amount of the fresh staurolite in north Georgia is brownish black or

nearly black in color. The luster is glassy to dull glassy, the fracture is uneven to conchoidal, and there is a cleavage parallel to the brachypinacoid face. Staurolite is pleochroic, thus fresh fragments may be distinguished from garnet with the dichroscope.

Crystal form

Staurolite crystallizes in the first class of the orthorhombic system, where crystals may be related to three axes of unequal length, all at right angles to each other. The crystal is arranged so that the short or brachy axis faces the observer. The intermediate or ortho axis extends from left to right, and the vertical axis is the long axis.

Several different forms may occur and others only as twinning planes. The three most common forms are the prism (110), basal pinacoid (001), and brachy pinacoid (010). The macrodome (101) is less common and generally not completely developed. Crystals vary greatly in size from place to place, generally tending to be of about the same size at individual localities. In some places specimens of large size up to several inches in length may be collected. Large crystals are more likely to be altered on the outside to sericite.

Twinning

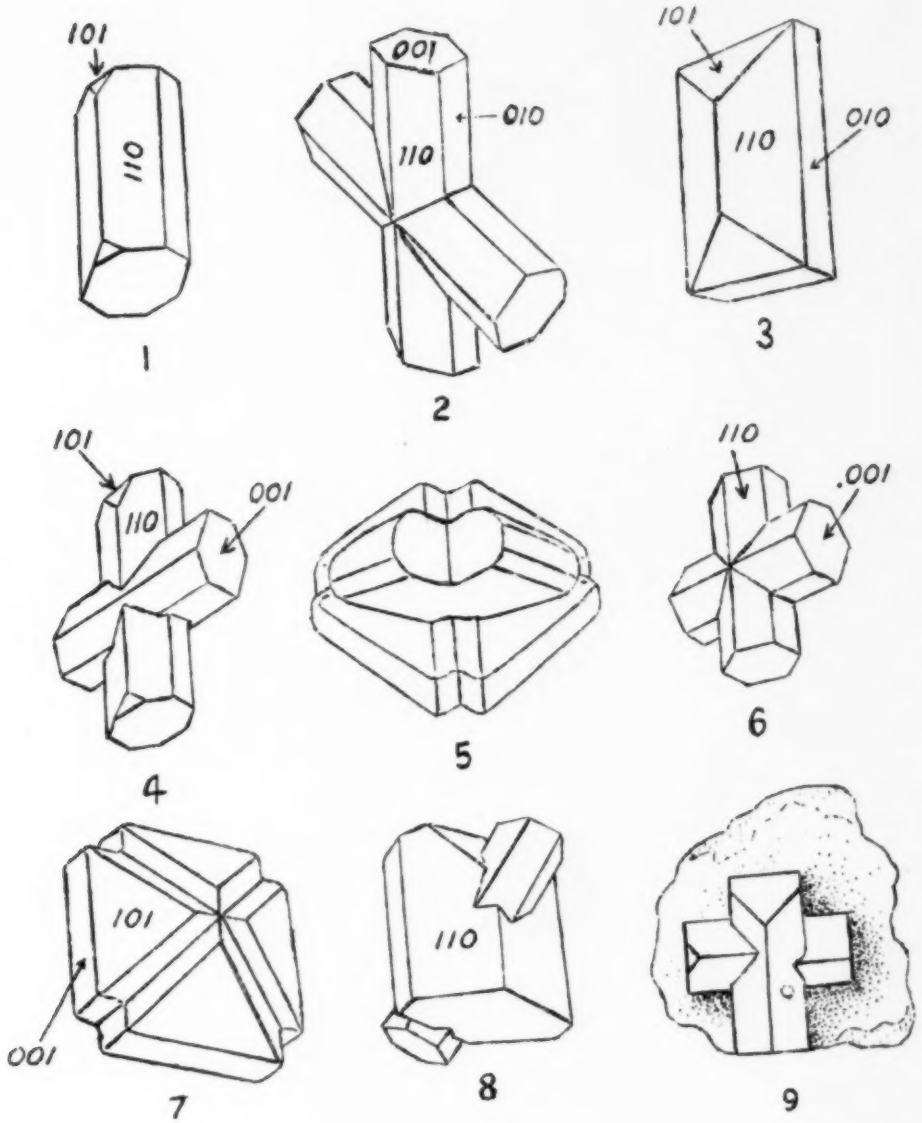
This is the most distinctive feature of staurolite. The Greek cross with both crystals of equal length, the cross approximately at right angles, is uncommon; but excellent specimens can be found at several localities. Most crosses of this type on the market are artificial, and generally the horizontal crystal is shortened, and the lower part of the vertical one lengthened to form a typical Roman cross. Crosses at about 60° angles are abundant, and most natural staurolite crosses are of this type.

By far the most abundant type of cross is illustrated by No. 2, where the two crystals make angles of approximately 60° and are twinned on the bipyramid face, z(232). In a second and much less common form (Nos. 4, 6, 7) the two crystals are twinned nearly at right angles, twinning plane x(032), a brachydome, but the cross is not rotated completely normal to the vertical axis of the supplementary crystal. An even rarer type, where three crystals interpenetrate to form triplets, involves both twinning planes mentioned above. No. 7 is produced by twinning of two crystals similar to No. 3 on x(032), but the re-entrant angles are unusual. No. 5 is a penetration "triplet" of this type from the J. E. Spear property near Ball Ground.

Out of 1526 crystals collected on the 1935 field trip from the Hackney place near Blue Ridge, Lane Mitchell reports 1226 were identified as follows:

776	plain prisms with one or two domes.	63.3%
402	twinned at approximately 60° .	32.8%
45	twinned at right angles	3.7%
3	multi twins	0.2%

The people in Patrick County, Virginia, have become very proficient in making artificial crosses from a talcose schist that is gray in color, and soft and easy to cut. They use bands saws fitted in modified grooves run by sewing machine pulleys for rough-cutting the rock, and the cross is finished up by hand with files. It is then soaked in oil to give it a brown color, somewhat resembling staurolite. Dr. Joseph K. Roberts states that they even went so far as to produce swastikas.



—J. Roy Chapman

Staurolite

Origin

Perfect staurolite crystals suitable for pendants are not common even where the crystals may be picked up in great quantities. Thus, a very high proportion of staurolite pendants sold commercially are manufactured from some other type of rock, and are not really staurolite crystals at all. Due to its peculiar method of growth in certain schists, staurolite contains numerous inclusions of other minerals. These are harder or softer than the staurolite and tend to weather out, leaving holes in the crystals. In the South, staurolite crystals weather out of the included schist in many places. In New England, where the rocks have been glaciated, occurrences of this type are rare, but from Virginia southward, where weathering has progressed for thousands of years, there are localities where the crystals may be picked up in great quantities. In some places these crystals are still fresh and preserve their natural color. At other places they show extensive alteration to soft sericite, especially on the exterior part of the crystal. This is true of many localities in Georgia.

Staurolite occurs in the East in a metamorphic schist that was once a sedimentary rock. During the period of great pressure and high temperature, this original rock, probably something like a shale, was altered to a mica schist. After the schist was formed, the staurolite crystals grew, and for that reason they enclosed other minerals of the schist. Staurolite is exceedingly abundant in Virginia and is widespread in a formation known as the Wissahickon schist. This schist, with its included staurolite, has been described from Buckingham and Appomatox counties, Virginia, by Furcron (Virginia Geological Survey Bull. 39, "James River Iron and Marble Belt, Virginia," 1935, pp. 31-33). Here the staurolite is associated with a mica schist which contains garnet, biotite, muscovite, quartz, chlorite, magnetite, etc. The rocks of this locality of the state have been remetamorphosed in a shallow zone, so that the staurolite and some of the other minerals have undergone a change known as retrogressive metamorphism; that is, the minerals have tended to go back toward the original composition of the shale. This type of rock is technically known as diaphthorite. Where this has occurred, only the outline of the crystals remain because the staurolite is completely altered to chlorite, sericite, etc.

General distribution

The general distribution of staurolite has been mentioned. The mineral is collected extensively in Virginia. A very excellent article on the subject entitled "Virginia Staurolites as Gems" by Dr. Joseph K. Roberts, of the University of Virginia, was published in the AMERICAN MINERALOGIST, Vol. 19, No. 11, 1934, pp. 549-52. In referring to the article, Dr. Roberts states that "artificial staurolite crosses are sold on the market and have been for some time, the material used being a soft rock which is sawed into forms resembling staurolite crosses." The natural staurolite twins occur in Patrick and Henry counties, Virginia; Roberts writes that although most textbooks on mineralogy mention Patrick County, the Henry County locality is the best in many respects for good collecting.

This mineral is especially abundant in the rocks of Virginia and Georgia, and probably also in the Carolinas. Dana reports numerous

occurrences from Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, North Carolina, and Georgia. In old mineral collections you will generally find specimens from Switzerland, where the small orthorhombic crystal occurs with kyanite in "paragonite" schist" — the schist which looks very much like the massive variety of sericite.

The writer is not familiar with the staurolite localities in the Carolinas, although there must be good ones in those states. Several years ago, Mr. K. H. Teague and the writer saw large staurolites several inches long in biotite gneiss intruded by hornblende gneiss between the Little Tenessee and Tuckaseigee rivers 4-5 miles southwest of Bryson City; also the same or a similar zone on the road to Fontana Dam about four miles from Bryson City. Undoubtedly, staurolite can be collected in North Carolina in the Great Smoky formation near its contact with Nantahala slate west of the Murphy marble belt. This is the geological position of the best Georgia localities.

Staurolite in Georgia

Our staurolite is found in north Georgia, principally in Cherokee, Pickens, Gilmer and Fannin counties. It occurs in the Great Smoky formation of Keith, and probably also locally in the Valleytown. It seems to have a tendency to occur in the upper part of the Great Smoky formation near the Nantahala slate. Generally when you find it, it is found in certain beds which are extremely altered to staurolite as well as garnet, and it may be traced for considerable distance locally. The writer knows of at least a dozen localities, especially in Cherokee and Fannin counties, where these minerals may be collected, and some of the localities are listed below.

Ball Ground

There are numerous occurrences of staurolite in Cherokee County south and west of Ball Ground (see Tate quadrangle). Any desired amount of staurolite crystals can be picked up along the road on the east side of Sharp Mountain Creek one mile west of Fairview Church. To reach this spot, take the Fairview Church road west 1.7 miles north of Ball Ground. Keep on the straight road and pass the church on the left. A little woods road on the left just before going down the hill to the creek is good collecting ground. Many of the crystals are broken, and the small ones are the most perfect. In general they are fresh, and nearly black in color.

One of the best known collecting grounds in the State is on the farm of Mr. J. M. Spear, Ball Ground, Route 1, on the north side of Bluff Creek, 4.5 miles west of Ball Ground. Turn left (west) at the Bus Station at Ball Ground, keep on the main road and ask questions. On the Tate quadrangle his place is represented by the house 0.6 miles E. 20 S. of Riverdale School. Mr. Spear states that collectors have frequented the place since he was a "shirt-tail boy," but the supply is inexhaustible. Many fine twinned crystals have been taken from this locality. At the surface many of the crystals have sericite on them. A pit of fresh rock here, as at some other localities, ought to produce very fine fresh hand specimens; and it could be done at very little cost.

Near Blue Ridge

There is a locality in Fannin County north of Blue Ridge which has been well-known collecting ground for many years. To reach this property, take the Copper Hill

road, turning at the traffic light on the Ellijay highway, and go 1.6 miles north from the railroad crossing. Turn left up-hill on a dirt road, passing two white houses on the left, going 0.8 miles to the left, turn on a plantation road in the woods; then go 0.3 miles to the home of Mr. J. Fred Hackney, Blue Ridge, Georgia, who owns the property. The best collecting ground for staurolite here is in the sands of a small creek below Mr. Hackney's house. Crystals were secured here for school museum sets distributed by the Georgia Geological Survey to the schools of the State. The property was visited by the Georgia Mineral Society on its first field trip in June, 1935. Specimens in the State Museum presented by A. J. Nitzschke of Blue Ridge are similar to the types found at this locality.

Collectors should be equipped with a pan and shovel in order to obtain crystals successfully from the placer. This little stream valley is also an unworked gold placer, and Mr. Hackney has some nice specimens of gold which he found near the stream. If this placer is ever worked, there will be an opportunity to collect a tremendous amount of excellent staurolite crystals. These staurolites are very well formed and show practically all varieties of twinning; also transportation has cleaned them up.

Mineral Bluff

Practically within the city limits of Mineral Bluff there is a well-known collecting ground for staurolite crystals. To reach this place, go through town and take the Copper Hill road as far as the second road on the right, a gravel road beyond the top of the hill. Opposite the entrance to this road is the house of Mr. E. D. Richards, and directly behind his house in the cleared land a large number of staurolite crystals may be picked up in a few minutes. These crystals are not twinned as frequently as in some localities, some are sericitized, and all of them include crystals of garnet. They are more abundant and larger than usual; thus it is possible here to fill your sacks quickly with the large economy size. Mr. Richards states that they may be picked up along this northeast-southwest trend for a half mile or more to the southwest.

Cole's Crossing

The best locality for the collector and crystallographer thus far known to the writer is west of Cole's Crossing in Fannin County, Georgia. Take the Murphy, N. C., road from Mineral Bluff and go 2.5 miles. Turn left to Cole's Crossing. Cross the railroad and go 0.8 mile to the first cross road. Staurolite can be collected all along the northwest side of the ridge here. On the road just northeast of the S. F. Dean house, good specimens illustrating most of the known forms and varieties of twinning can be collected at and near the base of the ridge. The percentage of twinned crystals appears to be higher here than for most other localities; also the specimens are not sericitized. The matrix at this locality is a slightly metamorphosed sericite phyllite, and the crystals are unusually well formed (No. 9). This place, or one nearby, supplied crystals described from "Mineral Bluff" in Danas' System of Mineralogy.

Between this locality and Mineral Bluff, and on the same side of the ridge, there is an old collecting ground on the C. S. Ray (deceased) place that is regarded as very good, but has not been visited by the writer.

(Reprinted from the Georgia Mineral Society News Letter.)

The Earth Sciences — 1949

by Science Service

AMERICAN MOTORS WILL HELP TAP ITALIAN UNDERGROUND HOT WATER WANTED FOR POWER

MILAN, Italy, Jan. 4 — Underground water, near red-hot lava beds not far from this city, is to be tapped with the aid of American machinery to obtain high-pressure steam to operate turbine electric generators, it was revealed here.

An order has already been given to the Westinghouse Electric International Company for two 300-horsepower mud pump motors and one 250-horsepower draw-works motor for use on the drilling rigs.

Engineers calculate that they can strike hot water under sufficient pressure to support a one-inch column a mile high. At the surface, owing to reduction in pressure, this water will turn to steam, which will be piped into the turbines. Eight additional drilling rigs are to be purchased soon.

PATENTS ON SHALE-OIL LISTED FOR SCIENTISTS AND INDUSTRIALISTS

WASHINGTON, Jan. 5—Shale-oil patents issued by the U. S. Government, both to Americans and others up until 1945, are listed, illustrated and described in a new publication of the U. S. Bureau of Mines. The bulletin will be of particular value to scientists, inventors and industrialists seeking the answer of how to get from this mineral the gasoline, fuel oil and organic chemicals needed to supplement petroleum products.

The title of the bulletin is An Index of Shale-Oil Patents. It was prepared by Dr. Simon Klosky, shale-oil chemist of the Bureau's staff. Copies may be obtained from the Superintendent of Documents, Government Printing Office, here for 75 cents. It is not available from the Bureau. A companion volume of later patents will be ready in about a year.

The study made in compiling this publication has one special application to Bureau activities. In the Act of Congress, authorizing the construction and operation of demonstration plants to produce synthetic liquid fuels, the Secretary of the Interior is also authorized to acquire technical data, inventions . . . and other rights and licenses under patents granted by this or any other nation.

RENO AREA EARTHQUAKES MAY CONTINUE FOR MONTHS

WASHINGTON, Jan. 6 — That jittery area west of Reno, Nev., centering around the border between Nevada and California, may keep right on shaking for months;—or it may already be rid of the earthquakes which have been going on for more than a week.

Seismologists explain that the Reno area has been getting a pretty normal sort of shaking. "The" quake is now listed as the big shock last Wednesday. Earlier tremors are considered "foreshocks," and those since as "aftershocks."

Generally, the seismologists explain, the aftershocks gradually diminish. This can take quite a while, however. The all-time record for aftershocks, since seismologists have been keeping track of quakes, followed the tremor at Helena, Mont., in 1935. Aftershocks of that quake were felt for a full year.

Earthquake scientists of the U. S. Coast and Geodetic Survey here are not surprised at the reports of some 150 shocks in the Reno area. Their records show a total of 400 to 500 tremors following the big Dominican Republic quake in the Caribbean in 1946.

The cause of the shaking that the California-Nevada region is getting is a slipping of rock in the earth. This occurs in what earth scientists call a fault. Faults occur in some instances at the earth's surface, but most of them are several miles beneath the surface.

AMERICAN MINING PRODUCTION HIGH IN 1948, BUT FULL DEMANDS WERE NOT MET

WASHINGTON, Jan. 10 — Although

1948 production from American mines forged ahead of the output of the previous year, full demands for certain metals were not met, partly due to domestic postwar requirements and partly due to the rehabilitation needs of war-scarred regions abroad.

The tonnage of minerals, metallic and otherwise, mined in 1948 exceeded that of 1947 by about 4%, according to a preliminary report just issued by the U. S. Bureau of Mines. The dollar value was 26% higher. Fuels made the most impressive gain of any mineral group with the value of mineral fuels produced increasing some 30%, partly a reflection of the record quantity of petroleum extracted.

Steel and aluminum in 1948 surpassed the previous year output, but the major nonferrous metals, copper, zinc and lead, lagged behind. Large gains in the quantity of bauxite for aluminum making and molybdenum for steel alloys were achieved, though both were produced at rates a third below 1944 figures. Mercury production was exceedingly low, 40% lower than in 1947 and the smallest since 1933.

Iron and steel production in 1948 was the third greatest in history with some 88,000,000 net tons of ingots and castings. It would have undoubtedly equalled the 1944 peak of 89,600,000 tons, the report states, except for the work stoppage at coal mines in April and, with lesser effects, shortages in transportation for coke and pig iron. Labor-management difficulties account in part also for the shortages in the output of copper, zinc and lead.

The United States was obliged to import nearly two-thirds of its bauxite needs during the year, but the achievement of a peacetime record aluminum production was made possible partly by a peacetime record output of domestic bauxite. Magnesium output was intentionally held low, awaiting wider consumer acquaintance with the advantageous properties of this metal.

Crude petroleum production increased 8% over 1947, and exceeded 2,000,000,000 barrels for the first time. Marketed production of natural gas increased 10%. Coal production, both bituminous and anthracite, decreased, the first some 5% of the 1947 record output of 631,000,000 tons. The anthracite decrease was slight.

ROCKS SHOW EARTH'S MAGNETIC FIELD SAFE FOR 100,000,000 YEARS

WASHINGTON, Jan. 15 — The earth's magnetic field has been pretty much the same for at least 100,000,000 years, a three-man field research team from the Carnegie Institution of Washington has discovered. They presented their evidence in the new issue of the Physical Review.

The three men, O. W. Torreson, Thomas Murphy and John W. Graham, cruised the western part of this country last summer in two specially equipped laboratory trucks. In various localities they carefully cut small blocks of sedimentary rock, and tested these for the orientation of their minute magnetic fields.

The rocks thus tested were once loose sediment that settled slowly on the bottoms of ancient seas, in geologic ages from 100,000,000 to 10,000,000 years ago. Any of the particles that happened to be of magnetic material naturally arranged themselves in line with the earth's magnetic field. But after the sediments had compacted and slowly hardened into stone, the orientation of the particles had to remain the same even when the earth's magnetic field shifted — and it never remains completely still. Thus the rocks held the history of the magnetic field at the time of their first deposition. Correlation of all field data shows that the earth's magnetic field during the whole 100,000,000 years has on the average been north-and-south, but with cyclic swings of 30 or 40 degrees on either side of true geographic north. This jibes very well with similar determinations previously made on much younger geologic formations: glacial clay deposits in New England, aged between 15,000 and 20,000 years, and million-year-old ocean-bottom samples brought up by a core-taking gun.

BETTER USES OF COAL AS SOURCE OF CHEMICALS EXPECTED FROM RESEARCH

PHILADELPHIA, Jan. 18 — Coal today is under scientific investigation as never before, scientists were told here. Fundamental studies are now being made in many laboratories to determine its possibilities, not only in the manufacture of synthetic liquid fuels but particularly as a source of the

thousands of essential chemicals which it can be made to yield.

Up to now, the nation's abundant petroleum supplies have discouraged the study of coal, the American Chemical Society was told here by Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh. Far too little fundamental reasearch has been done with this key mineral. We still do not know what coal is chemically, he said, and until we have this knowledge we are working under handicap.

Half the world's known reserve of coal is possessed by the United States, he stated. This nation has enough to meet all requirements for heat, light, power and transportation for more than 1,000 years at the present rate of consumption. Industrial leaders and technical experts believe that a large industrial development based on coal is in the making, and that a considerable expansion in coal production is imminent..

Atomic energy, in time, may replace coal for the production of power, he continued, but it can not succeed coal as a rich source of carbon compounds. Chemically speaking, the whole range of organic chemicals can be made from coal.

In the past, coal has been the source of the so-called aromatic compounds on which the dye, drug, and explosives industries were founded. Alcohols are among the many other substances which can be derived from coal. By-product ethyl alcohol from two synthetic fuel plants now nearing completion will equal about one-fifth of the nation's present production from all other sources.

Acetylene from coal can be the mother substance for hundreds of organic chemicals, and the same is true for ethylene. Great quantities of free hydrogen are released in the usual coking of coal, most of which is lost. The gas called methane, given off in the same process, is now being converted into valuable liquid products. The hydrogen could likewise be saved.

Wider uses of coal for all purposes are foreseen by Dr. Weidlein. The petroleum supply picture has changed so radically that national security itself depends upon the development of new sources of liquid fuels, he declared. A World War III would require double the fuels of the past conflict.

RUSSIA'S ATOMIC BOMB PROJECT MAY BE LOCATED IN CENTRAL ASIA

WASHINGTON, Jan. 20 — Russian efforts to build an atomic bomb may be concentrated in Central Asia in the Tashkent area. This is indicated in a survey of Soviet uranium deposits published here.

"A fair amount of authentic information" on Soviet uranium resources is available in this country, declares D. B. Shimkin of the Russian Research Center at Harvard University in the journal, Science.

The Soviets have discovered enough uranium in the past decade to make it possible to develop atomic power in the future in Central Asia, Dr. Shimkin says.

No Soviet uranium deposits are known which are as rich as the two main sources of the element for American atomic work, deposits in Canada and the Belgian Congo. Dr. Shimkin does not discuss the rich Czechoslovakian uranium ore which Russia is believed to be mining behind the iron curtain.

Richest uranium ores known to be inside the USSR are in Central Asia.

"It must be stressed," Dr. Shimkin points out, "that all of the Central Asiatic deposits are found within a radius of 250 miles from the important hydroelectric plants of the Tashkent area..." Latest available figures show that water power developments in this area produced 882,000,000 kilowatt hours of energy in 1943.

"Labor, transportation and climatic conditions are also favorable here," adds Dr. Shimkin.

The city of Tashkent, with an estimated population of more than half a million, is the capital of the USSR's Uzbek Republic. It is located north of Afghanistan and about 800 miles east of the Caspian Sea. The area was formerly called Turkestan.

Best known of the Central Asia uranium deposits is in the Fergana Valley, southeast of Tashkent. Prospecting for radioactive minerals in this area began in 1900, and expeditions to the region were sponsored by the old Imperial Academy of Sciences before the Russian Revolution.

Although fewer studies are known, two other areas may be termed promising for atomic ore hunting in the USSR, Dr. Shimkin reports. These are the region in Siberia between the Aldan gold fields and Lake Baikal and in western Russia in the Ukraine.

FISH FOSSILS OF CRETACEOUS BEING EXCAVATED IN VIRGINIA

WASHINGTON, Jan. 24 — Fossil skeletons of freshwater fish have been found in a road cut near Haymarket, Va,. and are being excavated for the Smithsonian Institution by Dr. David H. Dunkle. They belong to the upper Cretaceous period, approximately 175,000,000 years ago.

Fossils of this type are rare in this particular area, though similar ones are common in rocks found from Massachusetts to New Jersey. Related forms are also known from Australia and South Africa.

Nearest living relatives are found in the relatively primitive fish group known as the ganoids, of which the gar-pike and bow-fin or freshwater dogfish are best-known representatives.

HAWAII'S MAUNA LOA BRINGS FORTH LAVA AND TOURISTS, BUT NO DEATHS

RON ROSS
Science Service Staff Writer

WASHINGTON, Jan. 15—Relax, and don't waste any sympathy on the Hawaiians who have just had the world's largest mountain begin pouring out hot lava over their largest island. Unlike Vesuvius and other famous volcanoes, the eruption of a Hawaiian volcano is not a disaster but a rather profitable and generally harmless show.

Tourist trade always booms following a nice eruption by Mauna Loa or one of the other Hawaiian volcanoes, and this is no small industry in our statehood-ambitious islands. Scientists who risk death getting closeups of some volcanic eruptions have a safe field day charting lava flows in Hawaii.

No one has ever been killed by the eruption of Mauna Loa, despite the fact that "long mountain" is the biggest volcano in the world.

Not so tall as its twin volcano, Mauna Kea, Mauna Loa is actually the largest mountain in the world, in total volume.

Hawaiian eruptions are spectacular and violent, but they are not so much so as the more dangerous skyward fumings of most other active craters. Molten lava pours out at a great rate—more lava flows from Mauna Loa than any other volcano.

But there are none of the dangerous showers of ash, stones and hot mud which make most erupting volcanoes a pretty nazardous spot for sightseeing.

So closely studied are the Hawaiian craters that volcanologists usually can predict an eruption. Dr. T. A. Jaggar of the University of Hawaii has even worked out a cycle for forecasting Mauna Loa's frequent outbursts.

Officials of the U. S. National Park Service here said this eruption came as a surprise. The Hawaiian volcanoes have been a national park since 1916.

To predict eruptions, scientists use two different methods. One is a tilt measurement, made with a plumb bob suspended over a calibrated scale. When a sharp tilt is noted toward the center of the crater, it means that the volcano is falling away a bit. But when a sharp tilt is noted outward, pressure is rising in the crater and an eruption may be forthcoming.

Seismographs which register earthquakes also tip off most eruptions of the crater. Relatively large numbers of small shocks around Mauna Loa are recorded most of the time. When these become more intense, it generally indicates that lava soon may pour forth again.

Between the tilt and tremor calculations, scientists can usually let the world know sometime ahead of an eruption that the big mountain will be active soon.

Main danger from Mauna Loa is that lava flows may hit villages on the island or its main city, Hilo. But this can now be averted by bombings which are used to break up the channels formed by the molten lava.

A few relatively small bombs have successfully diverted the flow from Hilo before. This, incidentally, does not mean that bombs can set off a peaceful volcano, a tactic suggested during World War II.

THE BRYCE CANYON NATIONAL PARK

ROGER L. SPITZNAS
University of Missouri

—Photo by Roger L. Spitznas

Figure 1. The Hindu Temples, Bryce Canyon, showing the control in erosion as exerted by joints and alternating harder and softer beds of material.

To the park visitor who sees Bryce Canyon for the first time, the colorful Pink Cliffs formation (Wasatch) is a striking fairyland of erosion forms nestled in bowl shaped amphitheaters below him. Entry to the park is gained by a surfaced road through a canyon eroded into the western edge of the Paunsaugunt (Pawn-sa-gunt) Plateau. Red Canyon is a small though impressive preview of what awaits the visitor after his trip across the flat top of the plateau to the rim of the canyon.

The great impact of the first view of the erosion forms is aided and heightened by the suddenness with which the visitor comes upon the scene. The trip across the plateau top from Red Canyon offers no clue of what awaits the visitor; in fact, the canyon is so hidden below the rim of the plateau that it is a common experience for visitors to inquire at park headquarters as to the whereabouts of the canyon.

A complete coverage of the geologic history of the park region is

of such proportions as to require a monograph or professional paper and is not practical here. Information relating only most closely will be given herein.

The High Plateaus, including the Paunsaugunt with Bryce Canyon, are part of the Colorado Plateaus Province; therefore, there is a close relationship between the Paunsaugunt and Markagunt plateaus and the Grand Canyon of the Colorado region. Physiographically these units are related, and their past history is so interlocked that their separation would be a major error.

Of the five major divisions of geologic time, hereafter called Chapters, the first three (Archeozoic, Proterozoic, and Paleozoic) are represented in the rocks exposed within the Grand Canyon. Northward there is the Zion Canyon region where the rocks of Chapter Four (Mesozoic) are exposed in terraces and canyons. At Bryce Canyon are the rocks of Chapter Five (Cenozoic). This fifth chapter is the last chapter of the earth's history, and we may consider ourselves as living in the most recent part of this chapter which began fifty-five to sixty million years ago.

At the end of Chapter Four the Rocky Mountains and their related uplands were built from lands that had previously been near or below sea level. There followed a long period in which the elevated lands were greatly reduced by erosion. Following this long erosional period a large fresh-water lake, or series of lakes, spread over much of the states of Wyoming, Colorado, and Utah. Into this lake, or lakes, was brought a large amount of material that was deposited to form what is now the Pink Cliffs formation (Wasatch – Eocene?). Following the deposition of the Pink Cliffs formation in southern Utah, another formation, the Brian Head, which contains materials from volcanic activity was deposited. The age of the Brian Head is assigned to the middle of Chapter Five (Miocene?).

At a time following the deposition of the Brian Head formation there occurred differential uplifting of the lands in and around the High Plateau country. As a part of this uplifting of the lands, great cracks (faults) developed in the earth's crust, and the lands on the eastern sides of these cracks were uplifted above the lands on the western sides by as much as three to six thousand feet. Thus, we have something that resembles a gigantic stairway rising progressively from west to east through southern Utah. It is into the first of the three steps that Zion Canyon has been cut by the Virgin River. Into the second of these steps Bryce Canyon has been and is being cut by the erosive forces of Nature. The third of these giant steps, the Aquarious Plateau, is visible in the northeast from the rim of Bryce.

Concurrent with the formation of the big cracks (faults) many smaller cracks without displacement (joints) developed in response to the movement of the land, and these joints are disposed at high angles to each other, thus intersecting. These minor cracks, too, are important in the development of what is now seen in Bryce Canyon.

During the following uplift of the land, the erosive power of rains and melting snows was strongly active, and the higher lands to the east of Bryce were

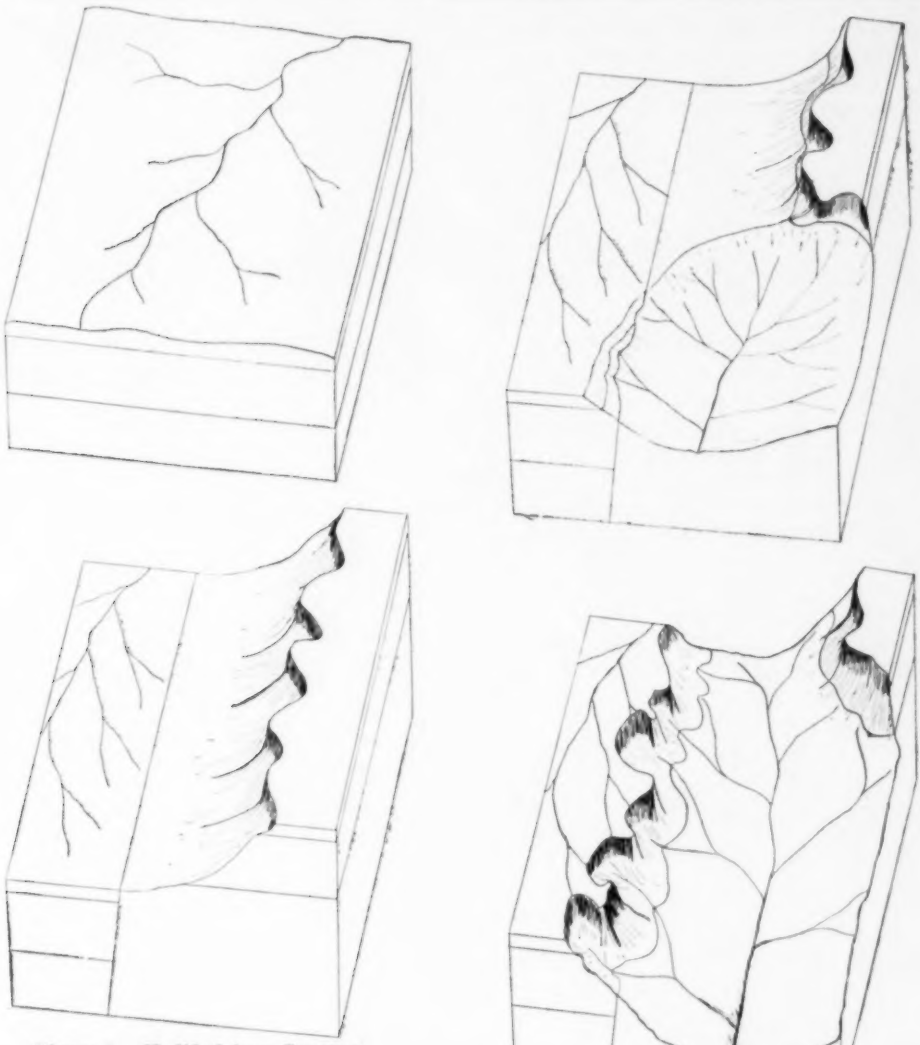


Figure 2. (Modified from Gregory)

A. Following the filling of the fresh-water lake, or lakes, there occured a period of slight erosion during which a stream pattern developed with drainage to the north. Relief was low, and the stream was sluggish throughout its length.

B. After the initial movement along the Paunsaugunt fault had taken place, the upthrown block was eaten into by the erosive agents, water, frost, and melting snow. At this period the drainage was still to the north through the ancestral Sevier River. The Pink Cliffs formation (Wasatch) and the younger Brian Head have been eroded back from the fault line forming a faultline scarp which is greatly crenulated.

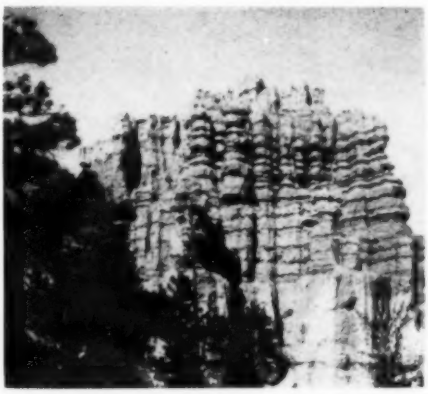
C. As the erosion of the plateau lands to the east progressed, a new drainage pattern (the present Paria River) began eating into the southern portion of the eastern plateau. Thus, an amphitheater, the Paria amphitheater, began its life. Also, it was at this time that the western plateau land, the Paunsaugun Plateau, was exposed along its eastern margin.

D. By now the Paria river has become a major drainage channel for the area, and having a greater gradient than the Sevier river, the Paria actively cut a huge amphitheater about twenty-five miles across and fifty to seventy miles long. As the amphitheater formed, the Paria captured much of the drainage area which had in the past contributed to the flow of the Sevier river. It is in this stage that we now find Bryce Canyon. The fuure will doubtless bring continuence of the removal of the Pink Cliff and Brian Head formations from the Paunsaugunt Plateau on the west with an ultimate reduction of the plateau to, or near, the level which the Paria River may make for itself.

subjected to much erosion (see figure 2). As the work of the waters continued, a bowl-shaped area was excavated by the rain and melting snow as they went toward a common channel, the present Paria River. As time passed and erosion continued, the present form of Bryce Canyon was created. This work has required an estimated thirteen million years.

Following the definition of a true canyon, Bryce Canyon is a misnomer, for the park area is not a canyon but rather a series of about fifteen bowl shaped amphitheaters in which parts of the rock have been left standing in odd forms while other parts were worn away by the action of frost, rain, and melting snow. The Indians had a more correct name for the area, the land of "red rocks standing like men in bowl-shaped canyon."

The rocks in Bryce Canyon are, for the most part, soft lime rocks though sand is present in some beds and clay material is present in others. A few beds of rock made up of pebbles cemented together by lime are present in the lower and the upper parts of the rock series, and these pebbly beds do offer some control in the removal of the rock by erosive agents. If the rocks within the area were of only one color, the region would not be nearly so attractive as it is. This coloration of the rocks in Bryce is brought about by two iron oxide minerals. The yellows, tans, and browns come from a hydrous iron oxide, limonite ($Fe_2O_3.3H_2O$), while the reds and pinks come from another oxide of iron, hematite (Fe_2O_3). There are also beds of pure or nearly pure white lime rock between and among the colored beds, and this variation causes much of the beauty of the park. Besides the



—Photo by Roger L. Spitznas

Figure 3. A castle view along the Fairyland trail, Bryce Canyon. The rock is the Pink Cliff formation, highly eroded into many strange forms.

presence of the pure colors as described above, there is an interesting intermingling of these colors to form a mottled affect which viewed from a distance takes color from all of the pure colors and blends them into something beautifully different.

The colors of the rocks in Bryce are not constant at all times as even the time of day with the different angles at which the light strikes the rocks appears to change their color. Also, the colors take on denser hues following showers, and all colors stand out more vividly.

The erosion forms in the amphitheaters are varied in size and shape to such a degree as to seemingly defy imagination and construction.

The forms that are now seen in Bryce Canyon were not always there, and they will not always remain. Each of the forms has its birth as the rim of the plateau is eaten into by the action of the rains, frosts, and melting snows. There are first block-like masses remaining after the retreat of the

rim, and these large blocks later are cut into individual forms as erosion continues. The last part of the life of these forms is spent as rounded mounds of rock before they are completely removed by erosion. Thus, the forms are never static but are changing with every rain, snow, and the almost nightly frosts. However, this change is so slow that in one man's lifetime little or no change can be seen. It is quite certain that there have been no major changes in the forms since the first white men saw the park area in the 1850's. It has been estimated that only two to three inches of material are removed from the forms in five to six hundred years which is indeed very slow by human standards.

The retreat of the rim of the plateau is estimated to be about one foot in fifty years which is considerably faster than the destruction of the forms by erosion. This would have to be the case, or no forms would be present in the canyon. The rate of retreat of the rim is relatively rapid even by human standards, and this retreat can be measured by the removal of material from around the roots of trees that live along the rim. There are many examples to be found along the rim where trees that in all certainty had their roots in solid ground are now standing with their roots bare. As the rim retreats, their roots are exposed, proving beyond doubt that the rim does actively retreat. Also, some measure of the rate of retreat can be made from the exposure of these tree roots.

Beyond the controls already mentioned is that control exerted by the presence of relatively harder beds in the sequence of rocks exposed here at Bryce. These harder beds serve to break the force of the rains that fall into the area and thus save the softer material from the full scale erosion that otherwise would remove the softer material at a much faster rate. These protective caps of harder rock are seen on most of the major forms, and their presence can not be over rated as a control in the development of the forms. If and when one of these protective caps is removed by erosion, the form will erode rapidly until another hard layer is reached and a new cap formed, or the form may pass into a degenerate mound if there is no remaining hard rock to form a new, though temporary, capping. Some forms may thus pass through several periods of decapitation as they age and are modeled and remodeled by erosion. These harder beds also help to enhance the beauty of the area. The resistant beds are intermittently scattered through the rock section and are separated by less resistant or softer beds. The softer beds are eroded away at a faster rate than are the harder beds, and the forms take on a fluted form just as though they had been turned on a giant lathe.

It is certain that the future will bring many changes to Bryce Canyon, and these changes will continue to be slow, though effective, over periods of millions of years. Just what will be the ending of the geologic story is beyond all possible prediction except to say that its true end will not come until the end of the earth, if such should ever come about. No person, place, or thing is free of the change wrought by Time and Nature as they proceed toward some unknown zenith, and Bryce Canyon National Park is but one of the many beauty spots created for our benefit, enjoyment, and wonderment in this seemingly endless march.

New Books

HISTORICAL GEOLOGY

HISTORICAL GEOLOGY — by Carl O. Dunbar. 1949. 567 pp. 380 illus.; $5.00. The eagerly awaited fourth edition of the Schuchert-Dunbar volume Historical Geology was released last month. No doubt the most striking thing about the new work is the complete revision of the illlustrations. About one-third of them are new and many others have been redrawn. Of particular merit are the new enlarged paleographic maps, which mask those areas which had been based entirely on inference by clouds, leaving no doubt as to the accuracy of the remaining portions. Among other things, the Geologic Time Chart has been redrawn, affording the student a clearer view of the biologic relationships of life.

The emphasis is upon the understanding of principles and conceptions rather than the memorization of paleontological and stratigraphical data. The aims and scope of the book perhaps might be best explained by the author himself:

"The history of the Earth is no drab roll call of the dead, but a drama in which the actors are real, live creatures and the stage the whole broad surface of our planet! The student must sense the action and feel the essence of high adventure in this 'March of Time,' as shifting scenes unfold and living actors cross the stage.

"This viewpoint has controlled both the arrangement and the treatment or subject matter in this volume. No extraneous material has been allowed to break its continuity, from the fiery birth of the planet to the unfolding of our modern world.

"Believing it more important for the student to learn HOW a geologist thinks about the earth than WHAT he

thinks about any particular detail, we have taken pains to explain principles of interpretation rather than to catalogue facts about the history of the Earth, appealing thus to understanding rather than to memory."—From the Preface.

A selected list of collateral reading is available to the student at the end of each chapter, concentrated mainly upon non-technical and semi-technical works for the beginner who wishes to do further reading in a particular subject.

This book is especially recommended for a one-term course in historical geology, or as required reading for the earth science enthusiast, for it presents the history of the earth and its inhabitants in a comprehensive yet clear and envigorating manner. John Wiley & Sons, Inc., New York, N. Y.

—J. M. E.

REGIONAL PUBLICATIONS UNITED STATES

California

THE MOTHER LODE COUNTRY (Centennial Edition). GEOLOGIC GUIDEBOOK ALONG HIGHWAY 49—SIERRAN GOLD BELT (Bulletin 141, Calif. State Division of Mines) — Prepared under the direction of Olaf P. Jenkins. 1948. 164 pp., 2 pls., 235 figs., 10 maps.; $1.00. Seldom has a work of such historic importance been published by our state surveys. Dr. Jenkins and his associates have produced a masterful guide to the Mother Lode country, interpreting the mineralogical and geological features of the region in semi-technical fashion, and mixing it well with the fascinating mining history of the area. It is the first of a series of guidebooks covering routes of particular geological, scenic, and historical interest.

The book is profusely illustrated with excellent photographs, concentrated particularly upon the building structures of the gold belt from 1848 to 1870. A series of geologic maps covers the entire length of Highway

49. Two color plates show eight views of the region. California State Division of Mines, Ferry Building, San Francisco 11, Calif.

GEOLOGY OF THE TESLA QUADRANGLE, CALIFORNIA (Bulletin 140, Calif. State Division of Mines) — by Arthur S. Huey. 1948. 76 pp., 11 pls., 3 figs.; paper-bound, $1.50; cloth-bound, $2.25. This report, fourth in a series of quadrangle maps and reports now being issued by the Division of Mines, presents a comprehensive picture of the geography, stratigraphy, and structure of the quadrangle, as well as the economic mineral resources. Many typical features of the California Coast Ranges are described. California State Division of Mines, Ferry Building, San Francisco 11, Calif.

Kansas

UPPER CAMBRIAN AND LOWER ORDOVICIAN ROCKS IN KANSAS (Bulletin 72, State Geological Survey of Kansas) — by Raymond P. Keroher and Jewell J. Kirby. 1948. 140 pp., 6 pls., 13 figs.; $0.25. This work was undertaken by the survey due to the increasing desire for a more complete knowledge of the older Paleozoic rocks of midcontinental North America, particularly by petroleum geologists. Concerned primarily with the determination of the character, thickness, stratigraphic sequence, and distribution of the Upper Cambrian and Lower Ordovician zones, it is based on the examination of well cuttings and cores. State Geological Survey of Kansas, Lawrence, Kansas.

KANSAS ROCKS AND MINERALS — by Laura Lu Tolsted and Ada Swineford. 1948. 56 p.., 30 figs.; $0.05. "The purpose of this booklet is to summarize, as far as possible in nontechnical terms, the various kinds of rocks and minerals found in Kansas and to describe them so that the student, the amateur collector, the boy or girl scout, and other interested persons can identify them." This is an

elementary guide to the more important minerals of the State, describing the rocks and minerals themselves, with little emphasis on the actual localities. State Geological Survey of Kansas, Lawrence, Kansas.

GEOLOGY AND GROUND-WATER RESOURCES OF SEWARD COUNTY, KANSAS (Bulletin 69, State Geological Survey of Kansas) — by Frank E. Byrne and Thad G. McLaughlin. 1948. 140 pp., 12 pls., 10 figs.; $0.25. State Geological Survey of Kansas, Lawrence, Kansas.

GROUND-WATER SUPPLIES AT HAYS, VICTORIA, WALKER, GORHAM, AND RUSSELL, KANSAS with special reference to future needs (Bulletin 76, Part 6, State Geological Survey of Kansas) — by Bruce F. Latta. 1948. 75 pp., 8 figs.; $0.10. State Geological Survey of Kansas, Lawrence, Kansas.

CANADA

FLIGHTS IN 1947 OVER THE REGION OF THE NORTH MAGNETIC POLE AND THE MAINLAND BETWEEN THE ARCTIC COAST, GREAT SLAVE LAKE, AND HUDSON BAY, NORTHWEST TERRITORIES (Paper 48-23, Geological Survey of Canada) — by Y. O. Fortier. 1948. Report and map, $0.10.

British Columbia

GEOLOGICAL MAP OF BRITISH COLUMBIA; scale 1 inch to 20 miles (Map 932A, Geological Survey of Canada). 1948. 2 sheets, $0.50.

TAKU RIVER MAP-AREA, BRITISH COLUMBIA (Memoir 248, Geological Survey of Canada) — by F. A. Kerr, (Compiled by H. C. Cooke). 1948. $0.25.

TAKU RIVER, BRITISH COLUMBIA; lat. 58-30 to 59-00; long. 133-00 to 134-00; scale 1 inch to 2 miles (Map 931A, Geological Survey of Canada). 1948. $0.25. This geological map is

contained in the above memoir and is also available for separate distribution.

New Brunswick

POINT ESCUMINAC, NEW BRUNSWICK; lat. 47-00 to 47-15; long. 64-45 to 65-00; scale 1 inch to 1 mile (Map 972A, Geological Survey of Canada). 1948. $0.25. A topographical map.

The above publications may be ordered by postal money order from the Geological Survey of Canada, Department of Mines and Resources, Ottawa, Canada.

Quebec

PRELIMINARY REPORT (No. 216) ON HEBECOURT LAKE MAP-AREA, ABITIBI-WEST COUNTY (Quebec) — by R. Bruce Graham. 1948. 26 pp., 1 map. Several promising deposits of gold and of base metals are known to occur in this area, consisting mainly of Precambrian rocks.

PRELIMINARY REPORT (No. 217) ON WASWANIPI LAKE AREA (WEST HALF), ABITIBI-EAST COUNTY (Quebec) — by Jacques Claveau. 1948. 16 pp., 1 map. Most of the rocks in this area are granites of various types. Rocks of sedimentary and of volcanic origin, however, occupy sections of the southern and northern parts of the area.

PRELIMINARY REPORT (No. 218) ON GOELAND LAKE AREA, ABITIBI-EAST COUNTY (Quebec) — by P. E. Imbault. 1948. 12 pp., 1 map. Clayey sand and gravel covers most of the area, and rock exposures are relatively scarce. Shear zones in the volcanic and sedimentary rocks, occurring in the southern half of the map-area, warrant the attention of any prospectors who might be in this area.

The above reports may be obtained by addressing a request to the Department of Mines of the Province of Quebec, Parliament Buildings, Quebec, Canada.

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